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[1] Contribution from the Ballistic Institute, Clark University, No. 7.

[2] Webster, A. G., "On A Means of Producing a Constant Angular Velocity," *Amer. Jour. Sci.*, **3**, May, 1897 (383–386).

[3] Webster, A. G., "An Experimental Determination of the Period of Electrical Oscillations," *Physic. Rev.*, **6**, 1898 (297–314); Hubbard, J. C., "An Experimental Determination of the Period of Electrical Oscillations," *Physic. Rev.*, **2**, 1, 1913 (247–249).

[4] Webster, A. G., *Proc. Nat. Acad. Sci.*, **5**, May 1919 (163–166).

[5] Webster, A. G. Thompson, L. T. E. "A New Instrument for Measuring Pressures in a Gun," *Proc. Nat. Acad. Sci.*, **5**, p. 258-263.

[6] Webster, A. G., "Some Considerations on the Ballistics of a Gun of Seventy-five-Mile Range," *Proc. Amer. Phil. Soc.*, **58**, p. 373–381. (Note by A. G. W. It should be stated that the linear law is not now considered exact. M. Lugot, of the Commission de Gâvre, informed the writer that the curves should rise a little above the straight lines, but the error is small.)

[7] Experiments to measure the compression are now in progress.—A. G. W.

CHARCOAL ACTIVATION

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Communicated by R. A. Millikan, February 20, 1920

The results obtained by Dr. Harvey B. Lemon on the variations due to heat treatment in the adsorption of gases by charcoal,[1] although published but recently, were obtained some time ago. There seemed two possible explanations of these results—either that the structure of the

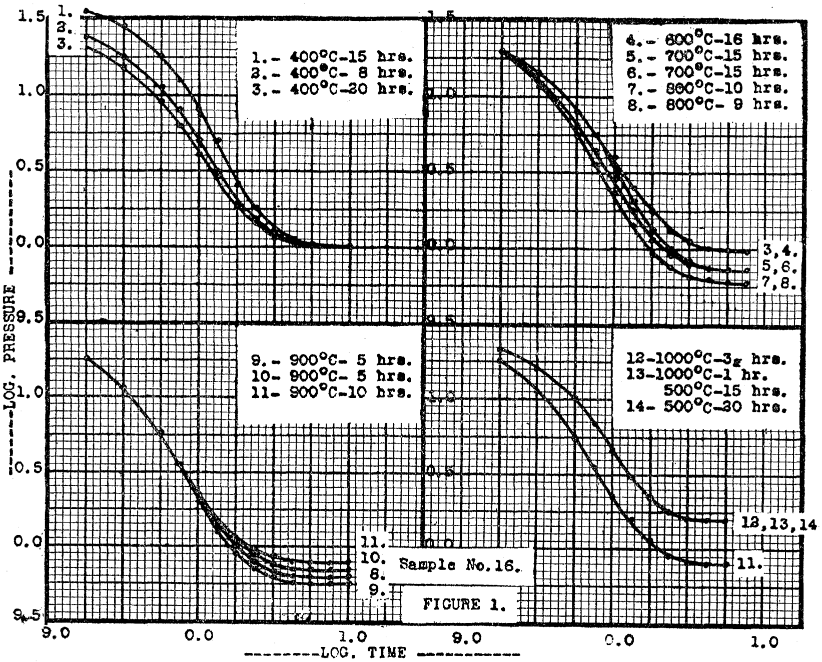

FIGURE 1.

charcoal was itself modified by heat alone or that the air was the agent causing these modifications. On this latter view a very complete theory, the hydrocarbon theory, has since been worked out by the Chemical Warfare Service.

The theory as published was not, however, substantiated by the appearance of any data in the journals, and accordingly certain experiments were begun here to satisfy ourselves regarding the conclusions arrived at. The apparatus and method were identical with those used by Dr. Lemon, and 25.7 gram of the same sample of charcoal, No. 16, was used. A similar sample to the one recorded was used as a check on all the work.

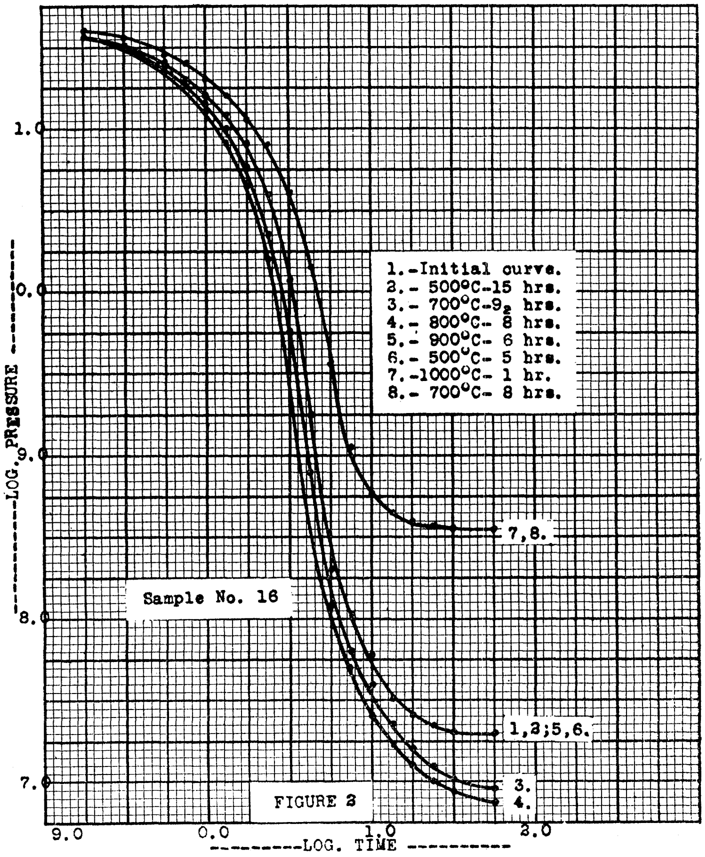

FIGURE 3

The constant end pressure after heat treatments up to 600° C. both in the hydrogen curves, figure 1, and in the nitrogen curves, figure 2, show that the activation recorded by Dr. Lemon for these temperatures, must have been due to oxidation. At temperatures between 600° C. and 900° C. activation takes place, accounted for by assuming that inactive hydrocarbons, stabilized by adsorption, are, however, being boiled away at this temperature. Above this we find deactivation, due to the breaking up of hydrocarbons at this high temperature which form an inactive carbon deposit on the active base.

In the case of U. S. Government 600 minute charcoal, no such deactivation at this high temperature was observed, but in this charcoal the hydrocarbons are supposedly all removed. It offers no contradiction therefore. The outgassings were as indicated on the next page.

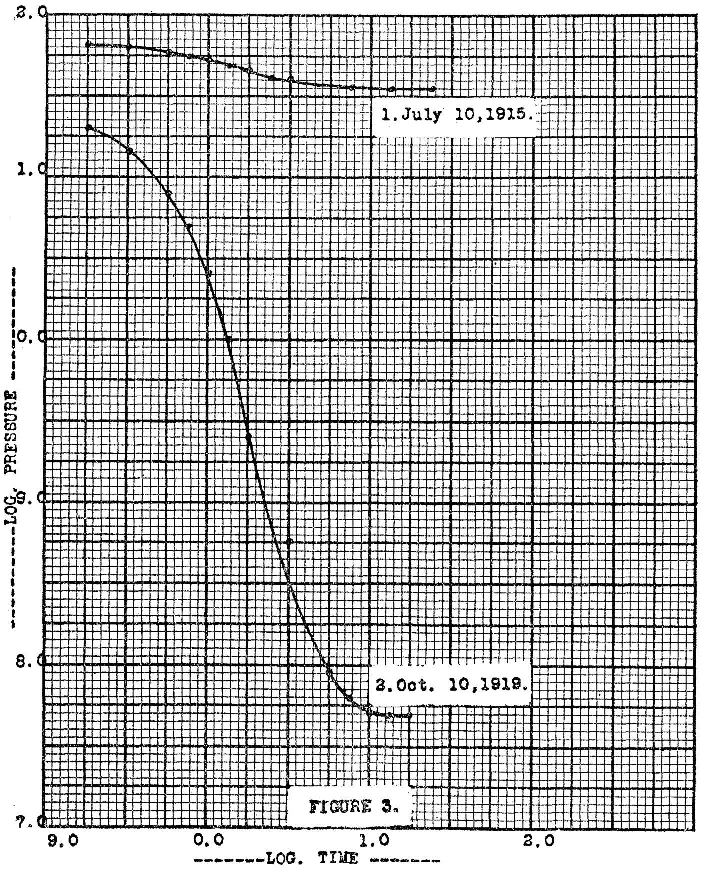

FIGURE 3.

Figure 3 shows how charcoal may be activated by slow oxidation at room temperature. Curve 1 was taken July 10, 1915, and the sample was then put away and left undisturbed until Oct. 10, 1919, when curve 2 was taken.

The ease with which the charcoal could be deactivated for nitrogen compared to deactivation for hydrogen, suggested that a sample might be put into such a condition that it would adsorb hydrogen more readily than nitrogen. Results of this sort are shown in figure 4; curves 1 and 2 are nitrogen and hydrogen, respectively, before treatment, and curves

3 and 4, the same after treatment. This treatment consisted of $3^1/_2$ hours at 1000° C. in a vacuum, kept down by a condensation pump.

FIGURE 1, HYDROGEN		
1	400° C.	15 hours
2	400° C.	8 hours
3	400° C.	20 hours
4	600° C.	16 hours
5	700° C.	15 hours
6	700° C.	15 hours
7	800° C.	10 hours
8	800° C.	9 hours
9	900° C.	5 hours
10	900° C.	5 hours
11	900° C.	10 hours
12	1000° C.	$3^1/_2$ hours
13	1000° C. 500° C.	1 hour 15 hours
14	500° C.	20 hours

FIGURE 2, NITROGEN		
1	Initial Curve	
2	500° C.	15 hours
3	700° C.	$9^1/_2$ hours
4	800° C.	8 hours
5	900° C.	6 hours
6	500° C.	5 hours
7	1000° C.	1 hour
8	700° C.	8 hours

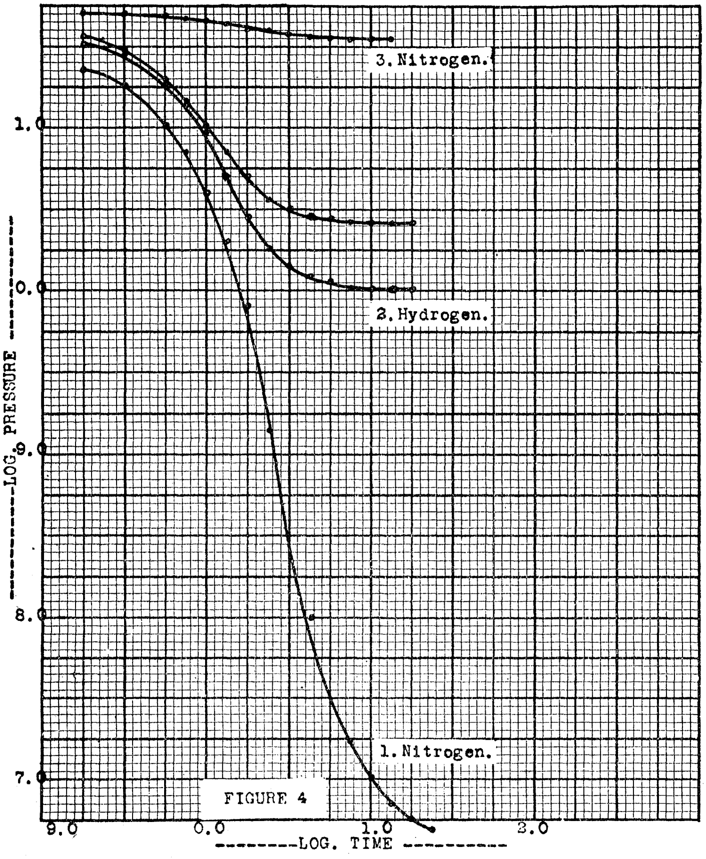

FIGURE 4

Several samples so treated worked successfully, and the fact that it was found impossible with U. S. Government 600 minute charcoal suggests that it was due to action of some sort between the hydrocarbons present and the gas. The fact that McBain's work[2] with hydrogen shows a dual action, and that work done later by others[3] on other gases points to a single action, suggests that while surface condensation is likely to explain the major action in both cases, that in the case of hydrogen there must be something else at work as well; either the hydrogen is dissolved or possibly combines with hydrocarbons unsaturated at this liquid air temperature. It is difficult to draw a distinct dividing line between the two, but the latter view is the one taken.

The deposit of inactive carbons on the active base, is according to this theory, much more effective in deactivating for nitrogen, since, interfering with surface condensation, it interferes with the whole effect, this not being the case for hydrogen which has a dual nature. The observations bear this out.

The decided drop in the initial end of the curves in figure 1 at the beginning of the work with hydrogen, which does not appear in the nitrogen curves of figure 2, again shows a difference in the adsorption of these two gases, possibly resulting from an increased fineness of the division of the material with which the hydrogen unites. Further work with other gases will be undertaken.

The author is greatly indebted to Dr. Harvey B. Lemon for valuable advice and suggestions in connection with this work.

[1] These PROCEEDINGS, **5,** July 1919, pp. 291–295.

[2] *Phil. Mag. London,* Ser. 6, **18,** 1909 (916).

[3] Miss Homfray, *Zs. Phys. Chem.,* **74,** 1910 (129).

THE STARTING OF A SHIP

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Communicated by L. B. Mendel. Read before the Academy, November 11, 1919

In this paper we give first the results of a mathematical discussion of the motion of a particle under the action of tangential forces depending only on the velocity of the particle.[1] In the following paragraphs we suggest applications of these results to marine engineering and to the study of the law of resistance of liquids.

We consider a particle, P, moving in any path under the action of forces whose components along the tangent to the path depend on the velocity of the particle alone. We denote the time by t, the distance covered in the time t by x, the velocity at the start by v_0, at any time t by v, and the acceleration along the tangent by a. By hypothesis, $a = F(v)$. Concerning $F(v)$ we assume